Discounting and the Value of Time

EES 3310/5310

Global Climate Change

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Class #33: Friday, April 3 2020

Should we spend more today
to offset damages in the future?

Should we pay \$100 for a bond today that will pay \$1000 in 50 years?

- What would you expect to earn if you invested \$100 today in something else?
- Compounding interest:

  $$V_{\text{future}} = V_{\text{present}} \times (1 + r)^n,$$

  where:
  - V is value
  - r is interest rate ($4\% \rightarrow r = 0.04$)
  - n is number of years
- Alternate formula:

  $$V_{\text{future}} = V_{\text{present}} \times \exp(r \times n)$$

- Rule of 72:
  - The number of years to double your investment is roughly 72 / (percent interest rate)

Should we pay \$100 for a bond today that will pay \$1000 in 50 years?

- What would you expect to earn if you invested \$100 today in something else?
- Assume real interest rate is 4%
  - Compounding interest:

$$V_{\text{future}} = V_{\text{present}} \times (1 + r)^n,$$

$$\begin{aligned} V_{\text{present}} &= \$100 \\ V_{\text{future}} &= V_{\text{present}} \times (1 + r)^n \\ &= \$100 \times 1.04^{50} \\ &= \$711. \end{aligned}$$

- $\$1000 > \$711$, so it's a good deal.

Should we pay \$100 for a bond today that will pay \$1000 in 50 years?

- Formula for net present value (NPV) is the inverse of the interest formula:

$$V_{\text{future}} = V_{\text{present}} \times (1 + r)^n$$

$$V_{\text{present}} = \frac{V_{\text{future}}}{(1 + r)^n}$$

$$\begin{aligned} V_{\text{future}} &= \$1000 \\ V_{\text{present}} &= \frac{\$1000}{1.04^{50}} \\ &= \frac{\$1000}{7.11} \\ &= \$141 > \$100. \end{aligned}$$

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Different Discount Rates

- Higher rate (10%)

$$V_{\text{present}} = \frac{V_{\text{future}}}{(1+r)^n} = \frac{1000}{1.10^{50}} = \$9 < \$100$$

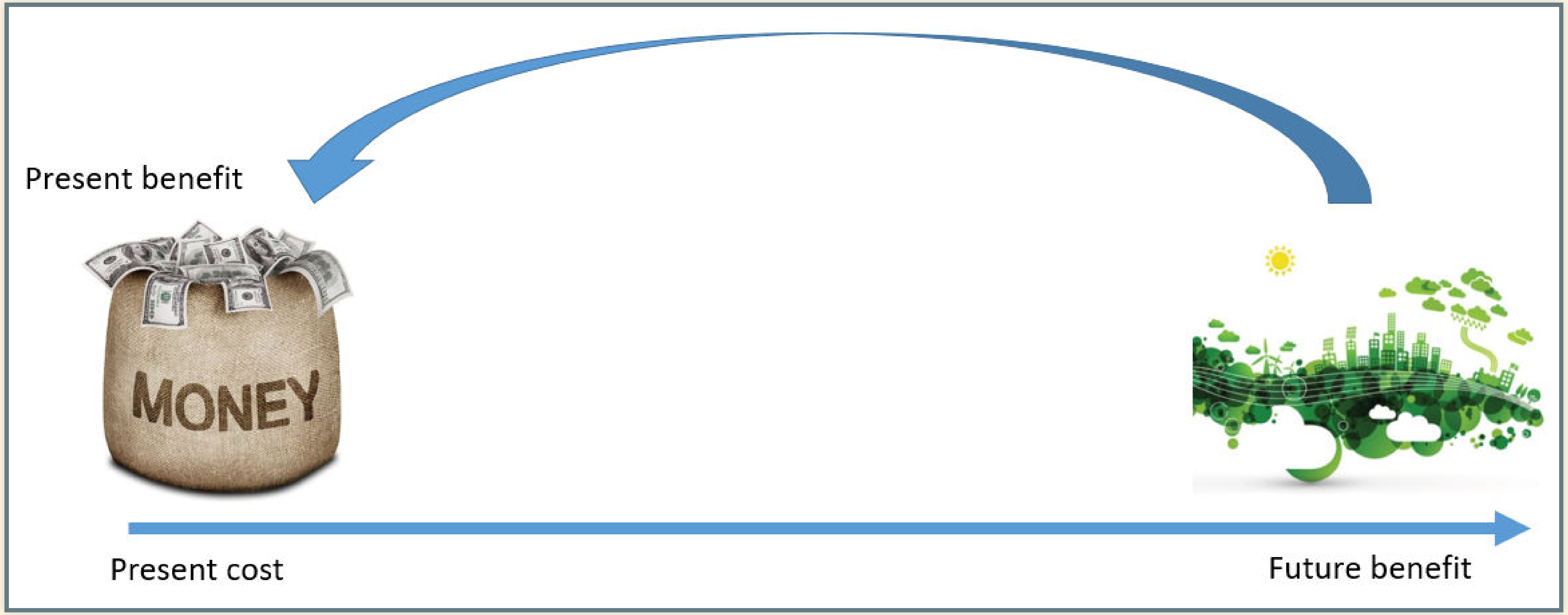
- Lower rate (1%)

$$V_{\text{present}} = \frac{V_{\text{future}}}{(1+r)^n} = \frac{1000}{1.01^{50}} = \$608 > \$100$$

Future Generations

Should we spend money today to offset damages in the future?

How much is it worth to us **today** to avoid climate disruption **in 100 years**?



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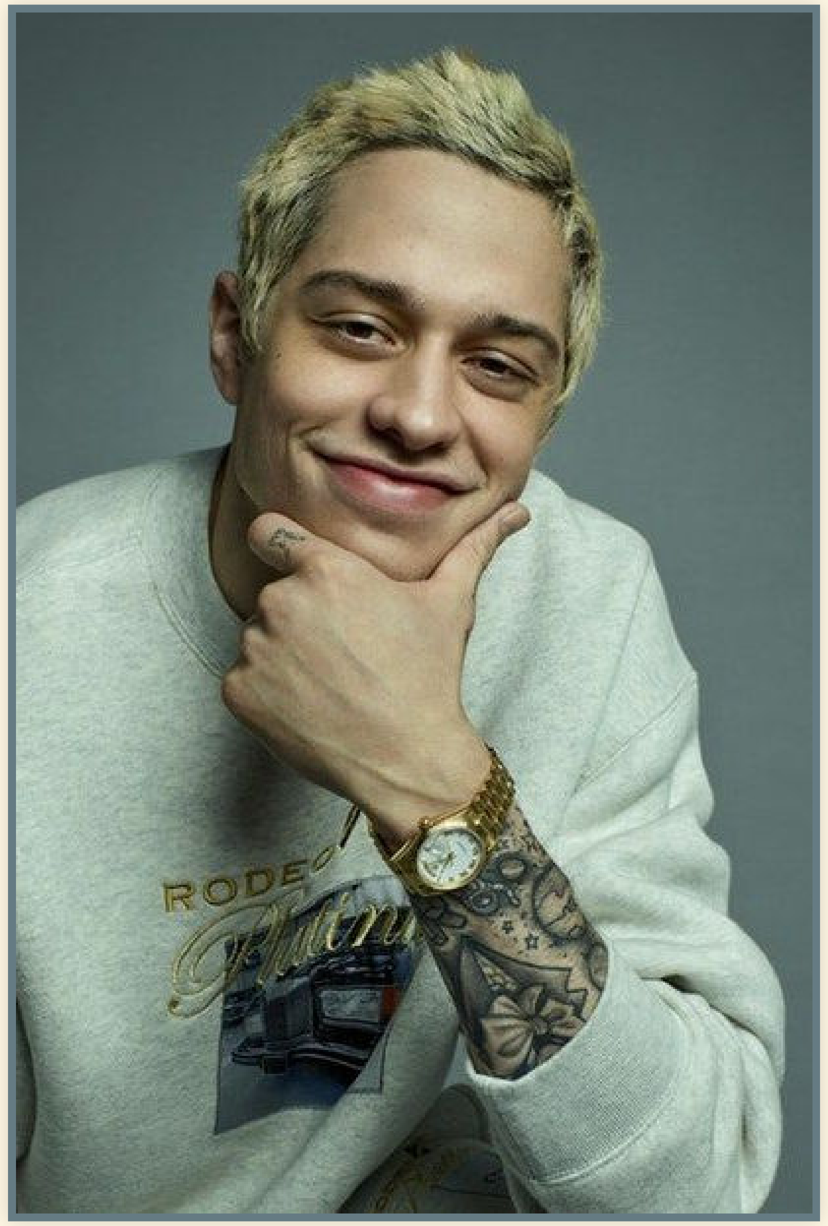
- How much is the welfare of your children worth, relative to your own welfare?
- Your grandchildren?
- Your great-grandchildren?
- Your great-great grandchildren?
- Your great^3 grandchildren?
- At what great^n do we stop?

Assume each future generation is worth half of the previous generation

$$1 + \frac{1}{2} + \frac{1}{2^2} + \frac{1}{2^3} + \cdots = 2$$



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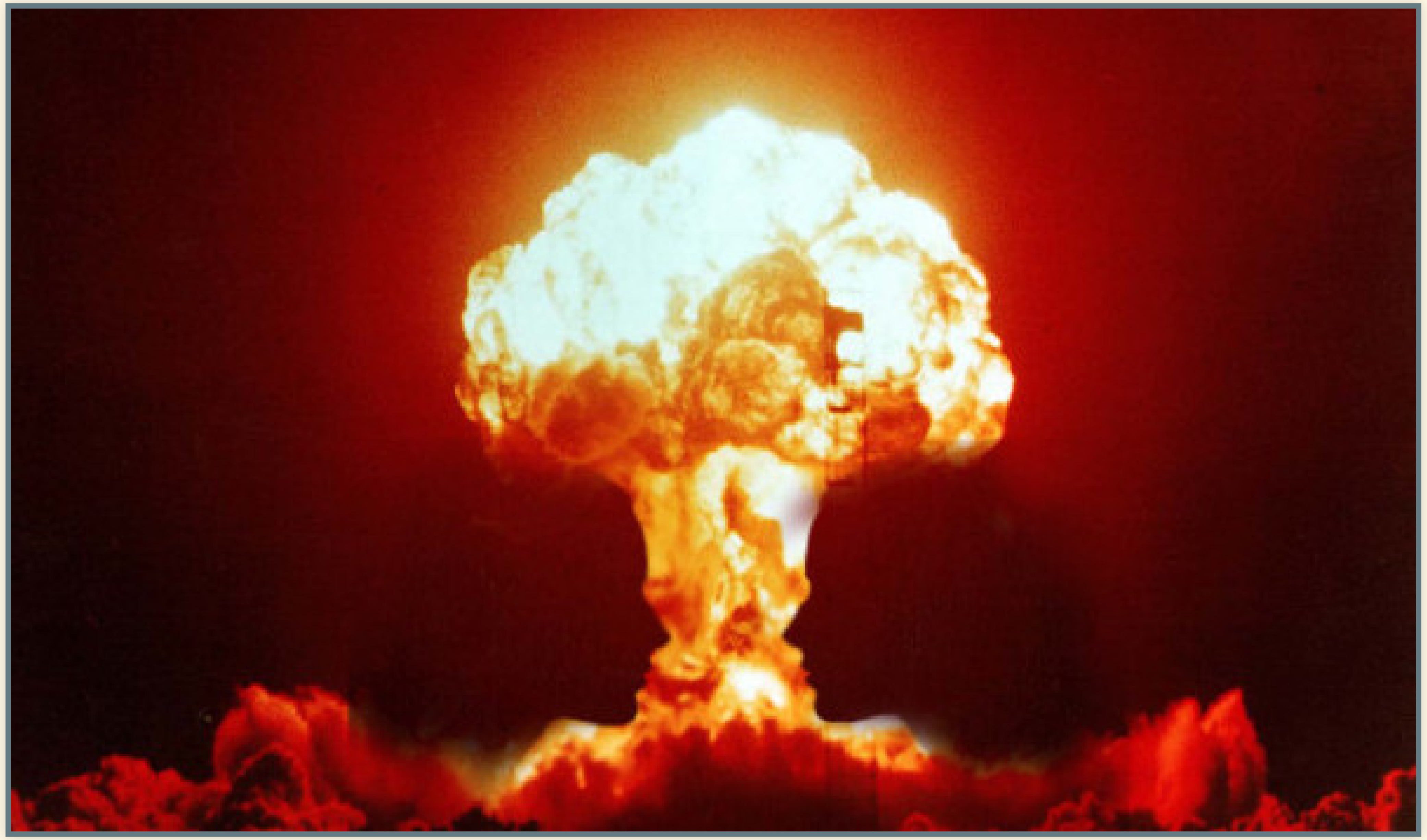


Assume each generation is equal

$$1 + 1 + 1 + 1 + \cdots = \infty$$

Valuing the present (high discount rate)

- We’re poor relative to the future!
- Don’t take from the poor (that’s us) to give to the rich (future generations)
- But if we apply this to **spatial** inequalities that exist **now** … justifies massive wasteful transfers from rich to poor

Rates Matter!

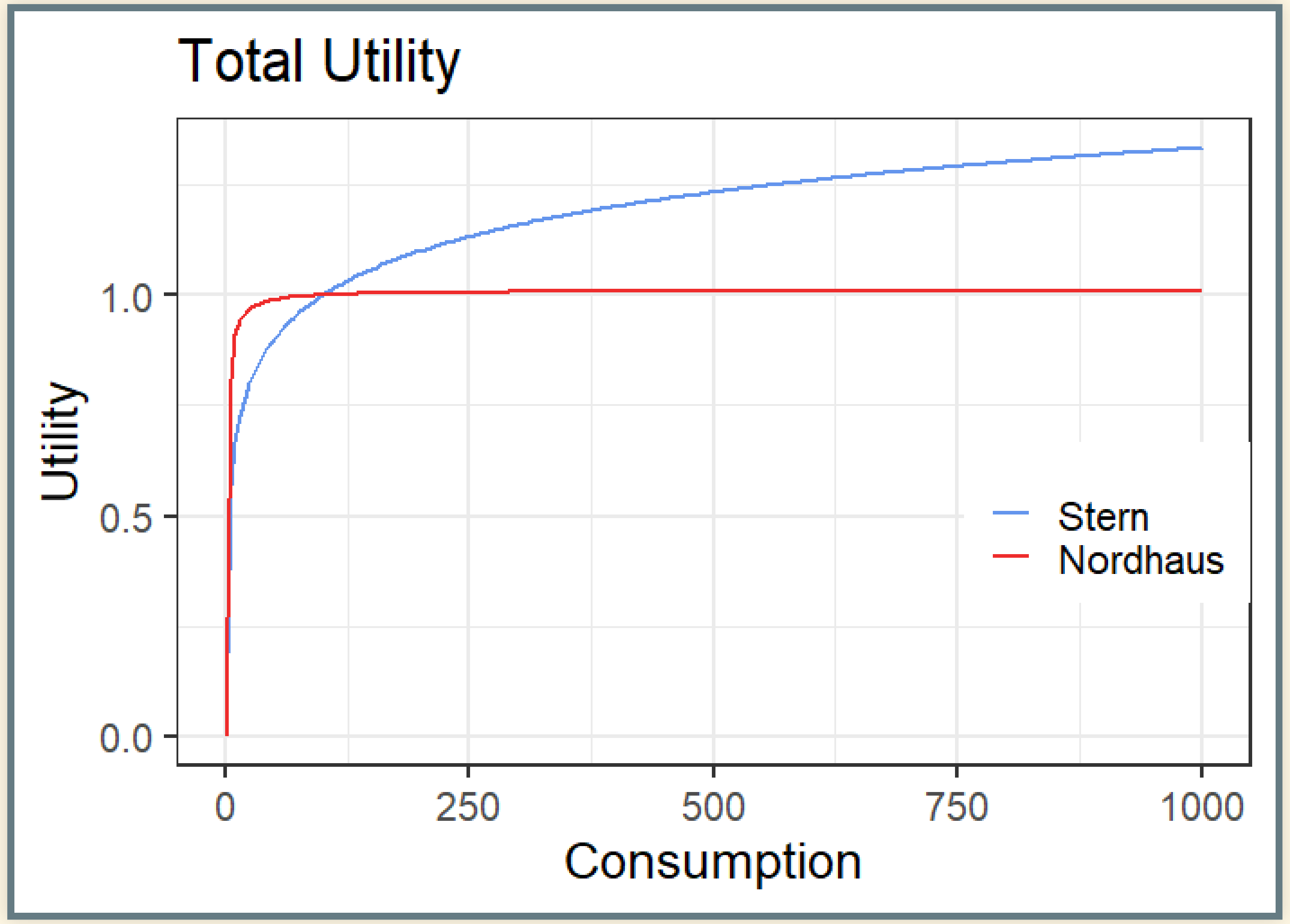
Stern vs. Nordhaus

Stern vs. Nordhaus

$$r = \rho + \eta g$$

Consumption elasticity η

- Proportional rate at which marginal utility of consumption is reduced as consumption increases (***What***?)
- Giving \$100 to someone in poverty adds more to total well-being than giving \$100 to Jeff Bezos
- High η: Value current consumption, strong benefits for redistribution from rich to poor
- Low η: Value future consumption, weak benefits for redistribution from rich to poor



- Stern: $\eta = 1$
- Nordhaus: $\eta = 2$

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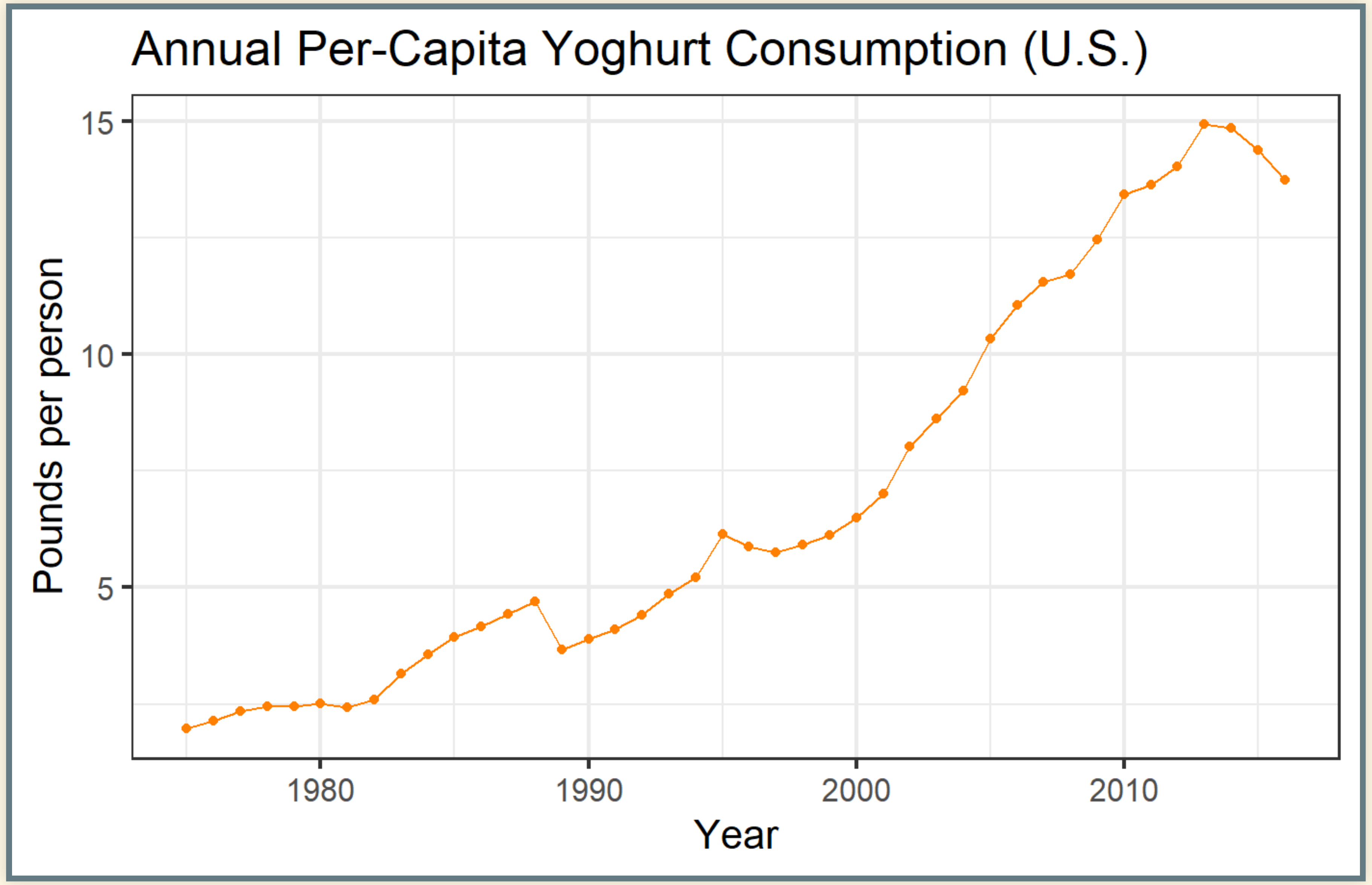
Time discount rate ρ

- How do we value future welfare, relative to our own?
- $\rho = 0$: All generations equal
- $\rho > 0$: Future generations count less than our own
- $\rho < 0$: Future generations count more than our own

- Stern: $\rho = 0.1\%$
- Nordhaus: $\rho = 1.5\%$

Per-capita consumption growth rate, g

- Stern: $g = 1.3\%$
- Nordhaus: $g = 1.3\%$



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Real return on capital r

- Potential of capital to create value
- High $r \rightarrow$ Wait and reduce emissions in the **future** (capital yield is higher in future)
- Low $r \rightarrow$ Reduce emissions in the **present** (future damages likely to exceed future output)

Stern vs. Nordhaus

$$r = \rho + \eta g$$

$$r = 0.1 + 1 \times 1.3$$
$$= 1.4$$

$$r = 1.5 + 2 \times 1.3$$
$$= 4.1$$

Discount Rates and Decarbonization

Discount Rates and Decarbonization

- Investing $10 million in wind today produces $100 million in real value 50 years from now
  - Rate of 1%: $V_{\text{present}} = \frac{\$100\text{M}}{1.01^{50}} = \$61\text{M} > \$10\text{M}$ 
  - Rate of 4%: $V_{\text{present}} = \frac{\$100\text{M}}{1.04^{50}} = \$14\text{M} > \$10\text{M}$ 
  - Rate of 7%: $V_{\text{present}} = \frac{\$100\text{M}}{1.07^{50}} = \$3\text{M} < \$10\text{M}$ 

Stern vs. Nordhaus on Implications of Discount Rate

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Nordhaus

... we need to use a discount rate that reflects the actual market opportunities that societies face, not an abstract definition of equity taken out of the context of market realities.

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Stern

... the benefits of strong early action far outweigh the economic costs of not acting.

... even at moderate levels of warming, all the evidence ... shows that climate change will have serious impacts on world output, on human life, and on the environment.

Stern Review, pp. xv–xvi

Stern

… we should go beyond the narrow framework of social welfare functions to consider other ethical approaches, including those involving rights and sustainability.

… disaggregated approach to consequences — looking at different dimensions, places, and times — and a broad ethical approach.

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